Title
TRANSMISSION SCINTIPHOTOGRAPHY

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Publication Date
1968-03-01

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March 1, 1968

Berkeley, California

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Submitted to Journal of Nuclear Medicine UCRL-18123

UNIVERSITY OF CALIFORNIA

Lawrence Radiation Laboratory
Berkeley, California

AEC Contract No. W-7405-eng-48

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Transmission pictures can be obtained of the lungs, diaphragm and heart in anterior, posterior and lateral projections using the scintillation camera with a radioactive source on the opposite side of the patient.

Transmission pictures are of use in interpreting conventional emission scintiphotos in which a radioactive pharmaceutical is administered to the patient and pictures showing its localization are taken with the scintillation camera. In the past there have been difficulties in relating these emission scintiphotos to the anatomy of the patient. Radioactive markers, optical photographs of the region, and standard radiographs have been used, but there are limitations to all of these methods. Transmission pictures largely overcome these problems in organs bordered by air because they show the exact position of the border in a scintiphoto that is the same size as the emission scintiphoto. The technique is proving of especial value in centering the heart and lungs for dynamic tracer studies. In lung perfusion studies taken using macroaggregates, radioactive bolus techniques, or

Xenon 133, the transmission pictures define the extent of the lungs, and the emission pictures can then be interpreted properly. In liver studies, space occupying defects between the liver and lung can be seen by comparing the transmission picture, which shows the lung, to the emission picture, which shows the liver. A discrepancy indicates a space-occupying lesion at the lung base or between the liver and the diaphragm. In cases of pericardial effusion, a transmission picture of the heart is compared with a blood pool picture. A difference in size indicates fluid surrounding the heart. Gas within the stomach and bowel is visualized and barium contrast agents can be seen in the intestine.

The use of transmission scans taken with a rectilinear scanner as a means of improving the anatomical orientation and interpretation of conventional emission scans has been reported previously by Kuhl, et al (1), and the technique has been used by Anger (2) to outline the body and lungs in the Whole Body Scanner Mark II.

To take transmission images with the scintillation camera, either a point source or an extended source is used, depending on the collimation method to be used in taking the emission pictures. If a multichannel collimator is to be used, a radioactive source in the form of a disc 11 inches in diameter is positioned underneath the patient, as shown in Fig. 1. A second multichannel collimator is placed on top of the source to

reduce the radiation dose to the patient and to produce a beam of parallel gamma rays. The use of two collimators reduces the amount of scattered radiation reaching the image detector and therefore improves the contrast of the image. If the source contains 10-20 mCi of Tc-99m, transmission pictures of the chest with 200,000 - 400,000 counts can be obtained in 1-2 minutes. The patient receives less than 1 milliroentgen per hour to the area of the body within the γ-ray beam and virtually no irradiation elsewhere. Thus a series of exposures lasting six minutes results in a dose less than 0.1 mr.

The 140 KeV gamma rays from technetium have very little selective absorption in bone compared with lower-energy gamma rays and x-rays (3). They are scattered by all tissues and therefore are especially useful for imaging air spaces within the body. Defects within air spaces, such as large solid lesions in the lung, can also be visualized. The quality and relative merits of transmission scintiphotos using gamma rays of different energy are being explored. I-125 ($\sim$ 30 KeV) and Tc-99m (140 KeV) give excellent heart and lung pictures. Adequate heart shadows can also be taken using Ba-133 (360 KeV), although contrast is reduced due to greater penetration of soft tissue by the more energetic γ-rays.

When possible the transmission picture is taken prior to administration of the radioisotope. Otherwise, the energy of the transmission γ-ray should be higher than that of the emission

gamma ray and proper pulse-height selection should be used if interference is to be avoided. In some cases, transmission and emission studies are recorded on the same sheet of film, and in this case the same isotope can be used in the source as in the patient. External metallic objects such as lockets produce shadows and should not be allowed within the camera field.

In both transmission and emission pictures taken with multichannel collimators, the parts of the subject closest to the collimator are sharpest in the resulting pictures. Thus, a PA transmission picture of the chest shows the heart clearly, while an AP view shows the spinal column better.

Transmission pictures can also be used in positron-camera studies. Since positron-coincidence collimation produces a slightly magnified image of the subject at the image detector crystal (4) a radioactive point source is used rather than a disc. The source is placed at the same distance from the image detector as the positron-camera focal-detector crystal so that the transmission scintiphotos have the same magnification as the positron emission pictures. No collimators are used. The source is housed in a lead shield so that an area only slightly larger than the image detector is irradiated. Ce-139 makes a very satisfactory source because of its energy (160 KeV) and half life (140 days). A 250 Microcurie point source allows pictures to be taken in 1-2 minutes.

The point source technique has been used in Rb-82 studies of the myocardium (5). It allows proper positioning of

the patient prior to the injection of the short-lived tracer, and it provides an accurate outline of the heart to aid in the interpretation of the emission pictures.

Four transmission views of the chest of a male weighing 150 lbs are shown in Fig. 2. They were taken using a collimated disc source of Tc-99m. In Fig. 2A the neck and upper lung fields are seen, and the pulmonary arteries and clavicles are visible as areas of slightly decreased transmission. The bright areas above the shoulders result from unabsorbed passage of gamma rays outside the body. Fig. 2B shows a left lateral decubitus view of the upper lung fields, showing the anterior and posterior body walls and the cardiac silhouette. The vertebral column cannot be distinguished in this projection using gamma rays of 140 KeV. Fig. 2C shows a supine posteroanterior view of the lower chest. The outline of the heart and diaphragm are well shown. Fig. 2D shows a prone anteroposterior projection showing the vertebral column and surrounding soft tissues. The heart border is less clear because it is further from the collimator in this view. The lower border of the lung is also not as sharp, probably because the diaphragm in this view is not in line with the gamma-ray beam.

REFERENCES

1. Kuhl, D. E., Hale, and Eaton, L.: Transmission scanning: a useful adjunct to conventional emission scanning for accurately keying isotope deposition to radiographic anatomy. Radiology 87:278-284, 1966.

2. Anger, H. O.: Whole-body scanner, Mark II (Abstract). J. Nucl. Med. 7:331, 1966.

3. Oosterkamp, W. J.: Monochromatic x-rays for medical fluoroscopy and radiography. Medica Mundi 7:68-77, 1961.

4. Anger, H. O.: Radioisotope cameras, chapter in Instrumentation in Nuclear Medicine, G. J. Hine, ed., Academic Press, Inc., New York, 1967. Also in Lawrence Radiation Laboratory Report, UCRL-11978, 1965.

5. Yano, Y. and Anger, H. O.: Visualization of myocardium with ultra-short lived Rubidium-82 and the positron scintillation camera. J. Nucl. Med. (In Press). Also in Lawrence Radiation Laboratory Report, UCRL-17865, 1967.

CAPTIONS

Fig. 1. Technique for taking transmission scintiphotos using a disc source.

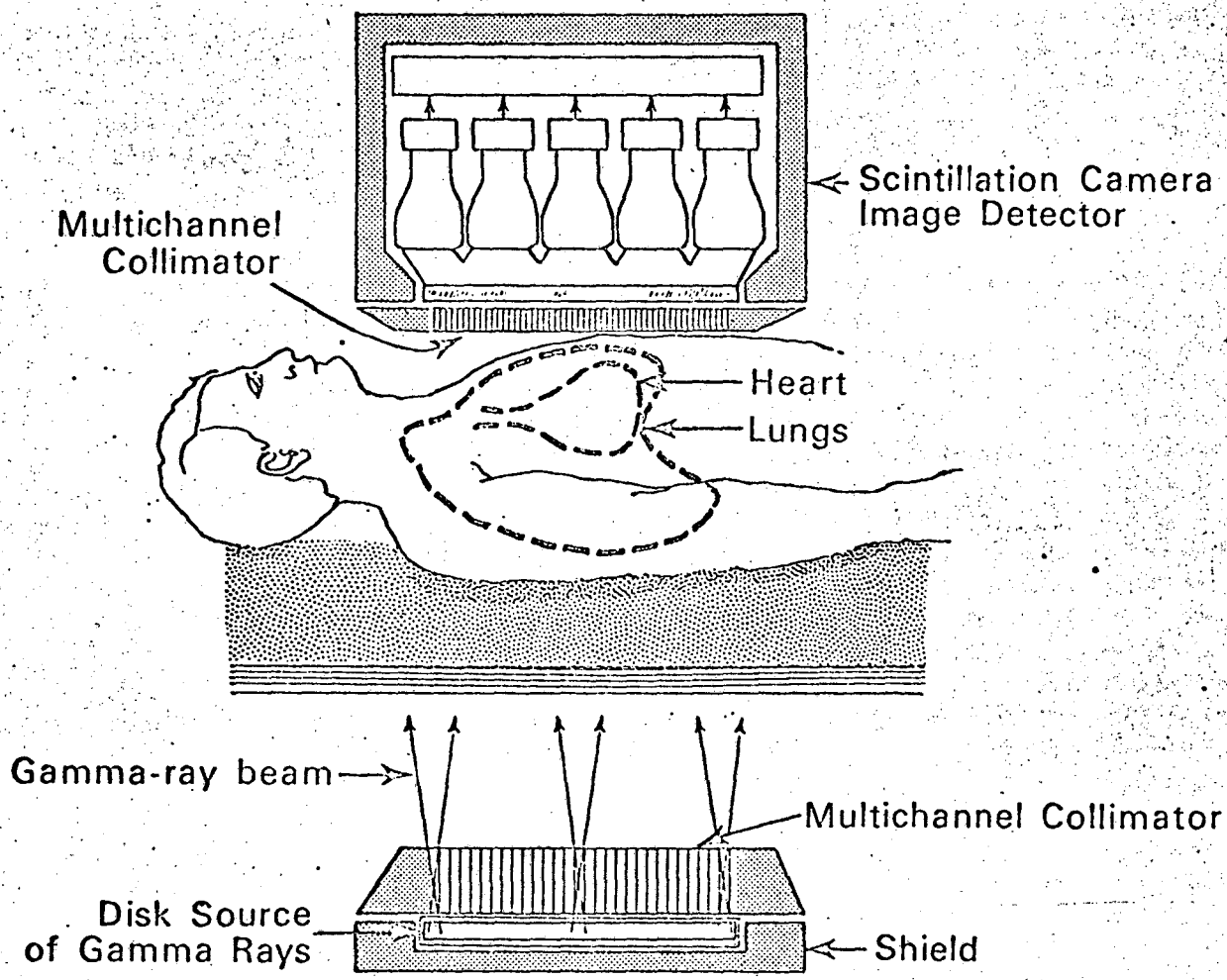
Fig. 2. Transmission pictures taken with Tc-99m gamma rays.

A. Upper chest, anterior view.

B. Middle chest, left lateral view.

C. Heart and diaphragm, anterior view.

D. Heart, spinal column, and part of diaphragm, posterior view.



Technique for Taking
Transmission Scintiphotos

Fig. 1

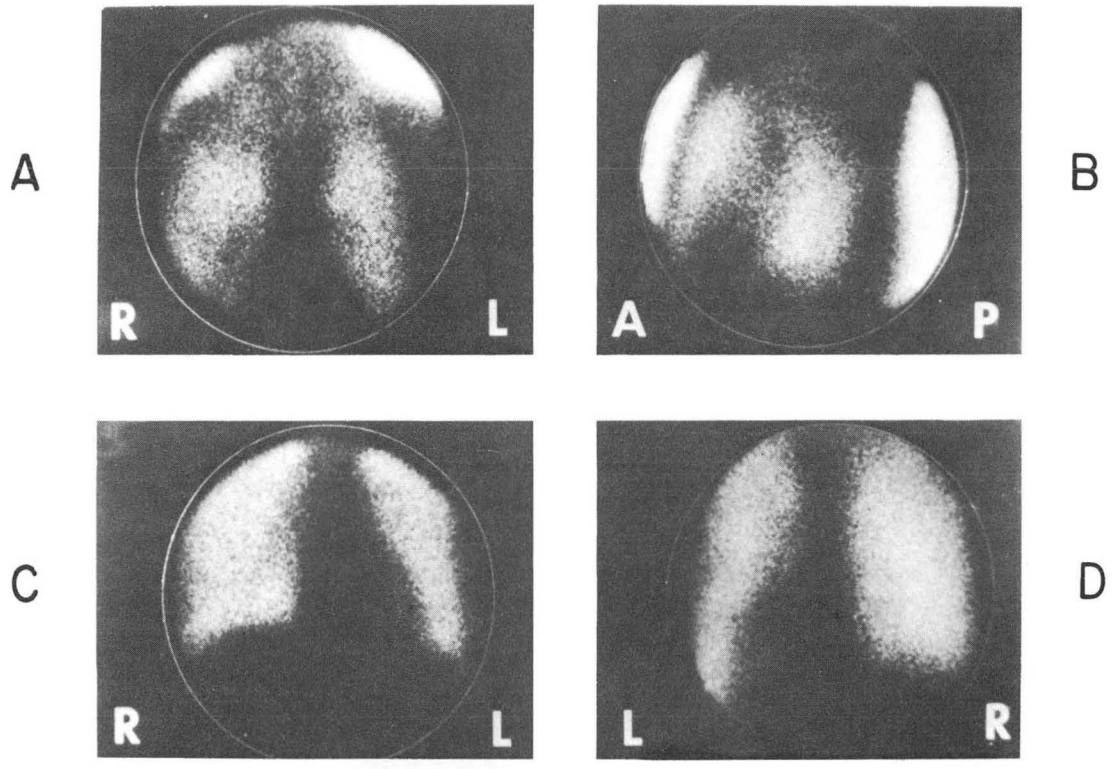


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Fig. 2